Brazilian Dental Science

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UNIVERSIDADE ESTADUAL PAULISTA
"JÚLIO DE MESQUITA FILHO"
Instituto de Ciência e Tecnologia
Campus de São José dos Campos

ORIGINAL ARTICLE

DOI: https://doi.org/10.4322/bds.2025.e4694

Diode laser vs. Monopolar electrosurgery in soft tissue crown lengthening and attached gingiva remodeling: assessment of growth factors levels associated with wound healing

Laser de diodo versus eletrocirurgia monopolar no aumento de coroa clínica em tecido mole e no remodelamento da gengiva inserida: avaliação de fatores de crescimento associados ao reparo tecidual

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How to cite: Kamel AM, Ali AI, Badr BM, Hudu SA, Ibrahim IH. Diode laser vs. Monopolar electrosurgery in soft tissue crown lengthening and attached gingiva remodeling: assessment of growth factors levels associated with wound healing. Braz Dent Sci. 2025;28(4):e4694. https://doi.org/10.4322/bds.2025.e4694

ABSTRACT

Objective: Diode Lasers and electrosurgery have been widely used as an alternative to scalpel manoeuvre. The implementation of both technology in periodontics was proposed to provide effective, comfortable framework. Thus, the purpose of the current trial was to evaluate healing process after treatment with electrocautery and laser from point of view of growth factors evaluation after soft tissue crown lengthening. **Material and Methods:** This study was carried out on eighty patients with short clinical crown and tissue of gingiva of anterior segment excised and attached gingiva remodelling done by Diode Laser in group I while in group II done by Electrosurgery. Width and thickness of attached gingiva prior to surgery (baseline), 30 - and 60- days and full mouth bleeding scores and epithelialization were recorded on 7-, 14- and 21 days after operations. Transforming Growth Factor-β1 (TGF-β1), Platelet-Derived Growth Factor-BB (PDGF-BB) and Basic Fibroblast Growth Factor (BFGF) were evaluated. **Results:** The intergroup comparisons showed statistical significance difference $p<0.001$ which indicated more effects of Electrosurgery than Diode laser in dispense of width of attached gingiva. Epithelialization was not completed until 21 days of healing in both groups. After 60 days, TGF-β1 and PDGF-BB appeared with no statistical significance difference $p= 0.53$ in comparison of (DLS) group versus (ES) group while BFGF showed statistical significance difference in comparing (DLS) group versus (ES) group. **Conclusion:** Diode Laser and Electrosurgery were considered effective for gingivectomy. Electrosurgery was more effective in remodelling gingival width and Diode Laser had more repercussion in bFGF.

KEYWORDS

Crown lengthening; Diode laser; Electrosurgery; Platelet-derived growth factor; Transforming growth factor beta1.

RESUMO

Objetivo: O laser de diodo e a eletrocirurgia têm sido amplamente empregados como alternativas ao bisturi convencional. A utilização dessas tecnologias na periodontia foi proposta com o intuito de proporcionar procedimentos eficazes e confortáveis. O objetivo deste estudo foi avaliar o processo de cicatrização após o aumento de coroa clínica em tecido mole, comparando os efeitos do laser de diodo e da eletrocirurgia a partir da análise de fatores de crescimento relacionados ao reparo tecidual. **Material e Métodos:** O estudo foi conduzido com oitenta pacientes que apresentavam coroas clínicas curtas. No grupo I, a excisão do tecido gengival da região anterior e o remodelamento da gengiva inserida foram realizados com laser de diodo; no grupo II,

empregou-se a eletrocirurgia. A largura e a espessura da gengiva inserida foram registradas no baseline, aos 30 e 60 dias. Além disso, os índices de sangramento em toda a cavidade bucal e o processo de epitelização foram avaliados aos 7, 14 e 21 dias após as cirurgias. Os níveis de TGF-β1 (fator de crescimento transformador beta 1), PDGF-BB (fator de crescimento derivado de plaquetas BB) e bFGF (fator de crescimento de fibroblastos básico) foram analisados. **Resultados:** A comparação entre os grupos revelou diferença estatisticamente significativa ($p<0,001$), demonstrando maior eficácia da eletrocirurgia em relação ao laser de diodo no aumento da largura da gengiva inserida. A epitelização não se completou até o 21º dia em ambos os grupos. Após 60 dias, os níveis de TGF-β1 e PDGF-BB não apresentaram diferenças estatisticamente significativas ($p=0,53$) entre os grupos, enquanto o bFGF apresentou diferença significativa na comparação entre o grupo laser de diodo e o grupo eletrocirurgia. **Conclusão:** Tanto o laser de diodo quanto a eletrocirurgia mostraram-se eficazes para a realização de gengivectomia. A eletrocirurgia foi mais eficiente no remodelamento da largura gengival, ao passo que o laser de diodo apresentou maior impacto sobre os níveis de bFGF.

PALAVRAS-CHAVE

Aumento de coroa clínica; Laser de diodo; Eletrocirurgia; Fator de crescimento derivado de plaquetas; Fator de crescimento transformador beta 1.

INTRODUCTION

Soft tissue recontouring around clinical crown is performed to optimize edges on sound tooth structure, achieving proper biological width, gain access for impression techniques and esthetics adjustments [1]. Many therapeutic modalities such as Scalpel surgery, Electrocautery and Laser surgery are used for crown lengthening [2]. Scalpel surgery had been predestined as the most common method because of its simplicity, controllability, and diminished destruction to periodontal tissue [3]. Healing after crown lengthening surgery occurs by secondary intention which engross about one month to rehabilitate accurate gingival epithelization, herewith enclosed a slow healing process [4]. This healing which consisting of overlying phases, hemostasis, inflammation, proliferation, and remodeling, may be slowed/impaired through abnormal oxygenation, microbial presence, venous supply deficiency, finally defective immune and inflammatory responses [5]. laser assisted surgery/ electrosurgery were proposed to accelerated/ optimize gingival healing after crown lengthening. Gingival electrosurgery with a high frequency electric current application produced minimal bleeding and reduced postoperative pain, however, there are some conflicting studies regarding the possibility of delayed healing after its use [6] .The diode laser has an affinity for only soft tissue, thereby preventing damage to the surrounding bone and enamel. Therefore, using diode lasers might be advantageous because of better control, potentially lower pain and inflammation, and improved wound healing [7]. Energetic polypeptide substances are biologically affecting immunological defense as well as divergent phases of wound healing in cells of epithelium, bone and connective tissue are known as growth factors [8]. These mediators regulate the cascade of events taking place during periodontal wound healing. Blood components are released into the wound site and platelets release alpha granules, which exert growth factors such as epidermal growth factor (EGF), platelet-derived growth factor (PDGF) and transforming growth factor-β(TGF-β). Fibroblast contraction and re-epithelialization by growth factors help in sealing the exposed underlying connective tissue [9]. There are plentiful pretensions made by the manufacturers about electrocautery and Laser surgery. These include efficacious soft tissue handling, stellar hemostasis, diminished pain sensation, less swelling and bestead wound healing. These pretensions regarding their clinical observations in oral surgery but till date there is no biochemical study comparing healing process after treatment with electrocautery and laser from point of view of growth factors evaluation after soft tissue crown lengthening.

MATERIAL AND METHODS

Study design and patient's selection

The Helsinki Declaration ethical guidelines were followed in this trial as its registration was manipulated in the Pan African Clinical Trial Registry database with ID: PACTR202501765821773. The current trial was a full mouth, single-center, longitudinal and double-masked (care operators and assessors) study. It was conducted for a total of 6 months, in which recordings were done from baseline, until 6 months. This study was carried out on eighty patients of both sexes with short clinical

crowns, ranging in age from 19 – 30 years and mean age 26±3.42 with short clinical crowns. All patients were selected from those attending the out-patient clinic, Oral Medicine, Periodontology, Diagnosis and Oral Radiology Department, Faculty of Dental Medicine, Al-Azhar University, Assiut Branch. A clinical examination was done on all patients who participated in the study. Informed consent was obtained from all patients before any study procedures were performed. The work research and scientific hypothesis were approved by the ethical committee, Faculty of Dental Medicine, Al-Azhar University. Soft tissue crown lengthening had been planned for each patient to involve anterior region.

Inclusion criteria

All patients need soft tissue removal, do not need osseous resection, and free from any systemic diseases. After initial periodontal treatment, included patients must show Full-Mouth Plaque Score (FMPS) ≤ 20% and Full-Mouth Bleeding Score (FMBS) ≤ 20% at baseline [10].

Exclusion criteria

Patients, with pacemakers or medical conditions contraindicating surgical interventions, pregnant or lactating women, with active periodontal disease (PD ≥ 6 mm), Clinical and/or radiographic signs of periapical pathology, were excluded.

Sample size calculation and power analysis

For the sample size calculation, the power analysis was performed using G Power system (Ver. 3.192 copy right 1992-2020) for a one-way fixed effect analysis of variance (ANOVA). The criterion for significance was set at $\alpha = 0.05$ (type I error) and $\beta = 0.20$ (type II error) to recognize significant difference (ϱ) of 0.5 mm between groups considering the change in thickness and width of attached gingiva as the primary outcome variables, with a 95% confidence interval. Therefore, the required sample size was found to be forty patients in each group with 95% actual power of this study was achieved.

Patient grouping

In the first group; soft tissue of gingiva of anterior segment excised and attached gingiva remodeling by Diode Laser. In the second group; soft tissue of gingiva of anterior segment excised attached gingiva remodeling by Electrosurgery.

Laser crown lengthening and attached gingiva remodeling technique (Figure 1).

The patients were anesthetized using infiltration technique. Specific protective glasses were used for patients, dentists, and assistants. Highly reflective instruments or instruments with mirrored surface were voided as there could be

Figure 1 - Clinical photograph of a female patient aged 20 years showing crown lengthening by electrocautery in upper teeth A) Pre-operative, B) Application of laser tip during procedure, C) Immediate post-operative, D) One week follow up, E) Three weeks follow up (right view), F) Three weeks follow up (left view).

reflection of the laser beam. The pocket depths in the surgical site were measured. Dots made in the gingiva by using Krane Kaplan tweezer, then area to be cut outlined by connection of dots using Sirolase ® (Diode laser, Sirona, Dentsply, Erlangen, Germany) lower power diode laser 970 ± 15 nm (0.5 watts) continuous emission mode contacting the tissue, power =3 watts, fiber 320 μm, fiber tip was initiated by using a dark articulating paper for 5 seconds. Continue to split the dots halfway until there was a continuing line of dots by using the diode laser. During the entire procedure, the tip was constantly checked for any debris of the ablated tissues and was cleaned with sterile moist gauze. Attached gingiva remodeling and physiological gingival contour was achieved by changing the angulation of the tip as required during the procedure. After the surgery, the end of the fiber (2-3mm) was cleaved to expose a fresh tip to prevent cross contamination.

Electrosurgery crown lengthening and attached gingiva remodeling technique (Figure 2)

Patients were anesthetized by infiltration technique. The pocket depths in the surgical site were measured using a crane Kaplan tweezer. Patients asked to hold the reusable silicone patient plate. The output power of electrosurgical unit (Zero50 Monopolar Electrosurgical unit, Zerona Co., Gunpo Si, Gyeonggi-Do, Korea) was kept at 38 watts rms ± 5%. The working frequency was adjusted to 1.5 MHz ± 5%. Continue to split the dots halfway until there is a continuing line of dots. Avoid the operation of equipment in a room with flammable or explosive materials. Rapid, well-planned movements without pressure as brushing strokes keep electrode moving all the time, using high enough current. A cooling period of 8 seconds should be allowed between successive incisions with the electrode. Continuous saline irrigation was given while using electrocautery. The excised tissues are removed with an Orban knife.

Postoperative instructions

Patients were instructed to avoid eating or drinking for one hour after surgery. Soft and cold feeding was recommended during the first post-operative day. Patients were advised to use cold fomentation at the day of operation to reduce edema formation.

Clinical evaluation

Clinical parameters including width and thickness of attached gingiva prior to surgery (baseline), 30 - and 60- days and Full mouth bleeding scores (FMBS) were recorded and

Figure 2 - Clinical photograph of a female patient aged 34 years needing crown lengthening which done by electrocautery in upper anterior teeth A) Pre-operative, B) Application of electrocautery tip, C) Immediate post-operative, D) One week follow up, E) Three weeks follow up (direct view of right side and indirect view of left side via mirror).

Wound epithelization on 7-, 14- and 21 days after operations. Changes of width of attached gingiva is the distance between mucogingival junction and gingival groove. It is measured using Williams periodontal probe. It is obtained by subtracting the probing depth from the total length from marginal gingiva to mucogingival junction. Changes measured by subtracting the width of attached gingiva after 30 - and 60- days from the width at baseline. Measuring the thickness of attached gingiva by #15 endodontic spreader with stopper was inserted mid-buccally halfway between gingival margin and mucogingival junction under local anesthesia. Changes measured by subtracting the thickness of attached gingiva after 30 - and 60- days from the thickness at baseline. Full mouth bleeding scores (FMBS) is measured by bleeding on probing (BOP) at a force of 0.3N. with a manual pressure of sensitive probe, recorded on distal, facial, mesial, gingival surfaces. Calculation = (Number of bleeding surfaces / total number of tooth surface) *100. Expressed in percentage (%) of gingival units bleeding on probing FMBS. In the rating system, 0 indicates absence of bleeding on probing, with 15%, 20% and >20% indicating an increased percentage of inflammation/infection. It was measured pre-operative, 7-, and 21- days post operatively.

Epithelization

A hydrogen peroxide solution (3%) was applied to detect the area of epithelization. H2O2 reacts with the catalase in the connective tissue and white foam developed. Conversely with epithelium, no foamy layer appears. standardized photographs assessed the area of interest. The photographs were taken perpendicular to the long axis of the central teeth. The width of the upper central tooth at right side was recorded for each patient and used reference measurement for photographs calibration [11]. Examination of photographs by Image J software (Java-based image processing program, National Institute of Mental Health, Maryland, USA) was done (Figure 3).

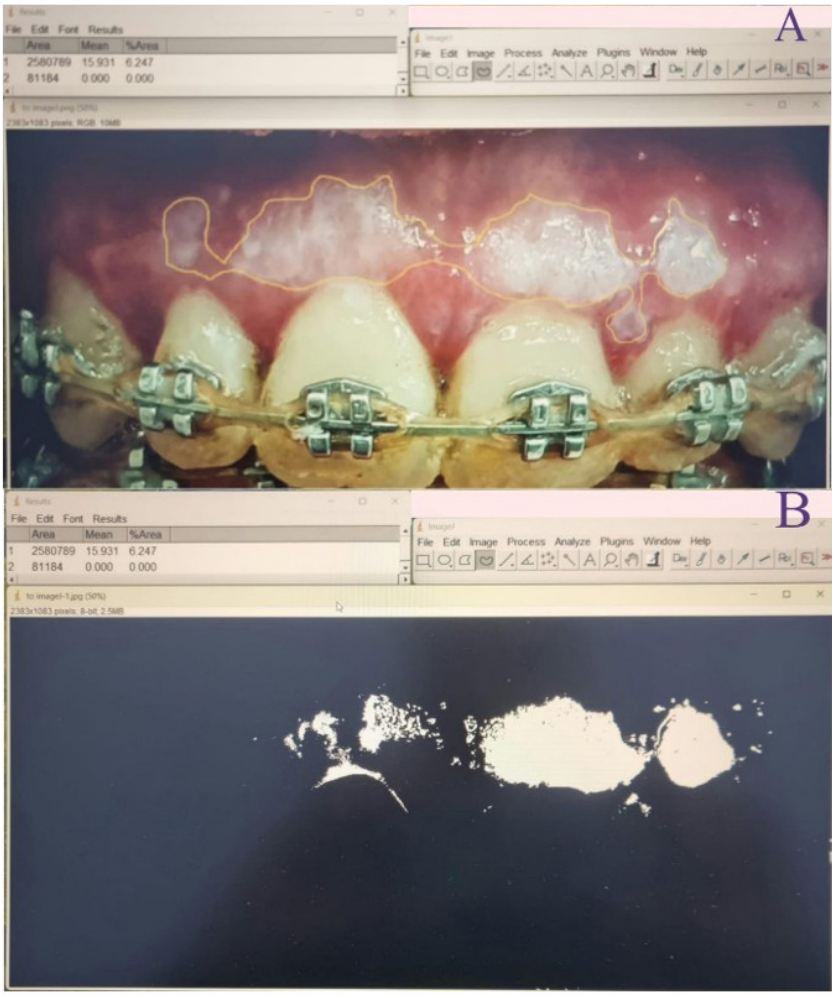

Figure 3 - A literal photo of the computer screen of Image J software program A) white areas of attached gingiva after application of hydrogen peroxide B) Subtraction tool application to calculate percentage of epithelialization.

Gingival crevicular fluid collection

GCF samples were collected immediately prior to surgery (baseline) and at follow-up visit (60 days). For each patient, six areas of sampling were identified at the line angles of upper anterior teeth. After isolation of selected sites with cotton rolls and the exclusion of saliva and supragingival plaque by a fine-bore high-power suction tip and a curette, respectively; A standardized paper point (30#) was carefully placed at the entrance of the crevice and left in position for 2 min to collect GCF. The paper points were pooled, transferred to plastic eppendorf tubes and stored at − 70 °C until elution was performed.

ELISA Measurements of Transforming Growth Factor-β1 (TGF-β1), Platelet-Derived Growth Factor-BB (PDGF-BB) and Basic Fibroblast Growth Factor (BFGF)

The paper points, saturated by GCF, could thaw at room temperature for 30 min. To elude the GCF samples, 50 μl of phosphate-buffered saline (PBS) was added to each tube containing the paper points and centrifuged at 11000 rpm for 15 min. Prior to estimation, Total volume of GCF within PBS was stored at 4°C for up to 24 hours. Analysis of each growth factor was performed separately because special preparations were needed for each one. The level of each growth factor was analyzed by using commercially available Sandwich ELISA kits (Quantikine DB 100, Quantikine DBB 00, Quantikine DFB 50, R and D Systems; Minneapolis, MN, USA) according to the manufacturer's directions. The substrate color reaction was measured at 450 nm by an ELISA reader (Stat Fax 2100 Micro-plate Awareness Technology, Inc. Florida, USA).

Statistical analysis

Data were recorded, computed, tabulated and analyzed at a significance level of $P<0.05$ by GraphPad Prism (version 8, San Diego, California, USA). The mean and standard deviation values were calculated for each group in each test. Normality of data was tested by the Kolmogorov–Smirnov test. comparison maneuvered by paired t- test while intergroups comparison contrived by unpaired t- test for dimensional changes of attached gingiva and fluctuations of growth factors. changes in FMBS and epithelization in both groups during different intervals expressed as Mean ± Std. intragroup comparison estimated by Repeated Measures ANOVA test while intergroups comparison observed by unpaired t- test. Linear regression was estimating correlations of growth factors levels with epithelization percent.

RESULTS

Eighty patients showed improved aesthetic/functional appearances throughout and at the end of the study period. Between March 2021 and November 2021, patients included in the final data analyses (40 in the Diode Laser Surgery (DLS) group and 40 in the Electrosurgery (ES) group). Demographic characteristics showing female gender was represented 75%, while mean age was 35±9.8 in the (DLS) group and 30±7.5 in (ES) group (Table I).

Changes in dimensions of attached gingiva

Diminution in width of attached gingiva scored in both groups during all observations period with statistical significance difference $p<0.001$ and maximum changes (3.25±0.57) mm recorded in electrosurgery group after 30 days. This rate of width diminutions was slackened at 60 days with few millimeters gain observed, but this gain was still less in electrosurgery group than Diode laser surgery group. The intergroups comparisons showed statistical significance difference $p<0.001$ which indicated more effects of Electrosurgery than Diode laser in dispense of width of attached gingiva. Shrinkage in thickness of attached gingiva descried in each group until end-point observation period with statistical significance difference $p<0.001$.

Table I - Demographic data of the study population in the (DLS) group and (ES) group. DLS; Diode Laser Surgery, ES; Electrosurgery

		(DLS) group	(ES) group
Gender (n, %)	Male	11 (13.75%)	9 (11.25%)
	Female	29 (36.25%)	31 (38.75%)
	Age (mean ± SD)	35±9.8	30±7.5
Smoking Status (n, %)	Smoker	2 (2.5%)	10 (12.5%)
	Non-smoker	38 (47.5%)	30 (37.5%)

When comparing between groups after 30 days, the trial elucidated statistical significance difference $p<0.001$. At 60 days evaluation endpoint, the effects of Electrosurgery and Diode laser appeared as the carbon-copy with no statistical significance difference $p= 0.244$ (Table II).

Curtailment of bleeding was perceived in both groups in all observation periods with statistical significance difference $p<0.001$ in every group and this indicated that both techniques were effective in control of bleeding while there was no statistical significance difference in intergroups comparison at any interval as following $p= 0.63$ after 7 days, $p= 0.08$ after 14 days and $p= 0.35$ after 21 days (Table III).

Evolution of epithelization

After crown lengthening and attached gingiva remodelling preformed with both techniques (Diode laser& electrosurgery), the process of epithelization began slowly and gradually to be restored all epithelial layer with statistical significance difference $p<0.001$ in every group at different interval comparison with repeated measure ANOVA test. It is noticed that epithelization was not completed until 21day of healing in both groups. When comparing Diode Laser and electrosurgery at each interval, there were statistical significance differences as $p= 0.015$ at 7days and $p<0.001$ at 14-,21- days (Table III).

Growth factors estimation

Concentrations of TGF-β1 and BFGF (pg/ml) were diminished after crown lengthening and attached gingiva remodelling with statistical significance differences $p<0.001$ in each group at comparing baseline to 60 days after procedures. By comparing between both groups at baseline, there was no statistical significance difference in TGF-β1 and BFGF (pg/ml) as $p= 0.804$ and $p= 0.307$, respectively. After 60 days, TGF-β1 appeared with no statistical significance difference $p= 0.53$ in comparison of (DLS) group versus (ES) group. BFGF estimated with statistical significance difference $p<0.001$ in comparing (DLS) group versus (ES) group after 60 days. Concentrations of PDGF-BB did not show any changes after crown lengthening and attached gingiva remodelling and no statistical significance differences reported at comparisons between both groups at baseline and 60 days thereafter (Table IV).

Correlations of growth factors and epithelization percent

Linear regression was elucidated that there wasn't any correlation of growth factors with

Table II - illustrate changes in width/thickness of attached gingiva in both groups during different intervals by Mean ± Std. intragroup comparison manipulated by paired t- test while intergroups comparison manipulated by unpaired t- test. DLS; Diode Laser Surgery, ES; Electrosurgery, T0; baseline, T30;30 days, T60; 60 days

Changes of width of attached gingiva (mm)	T30-T0 (DLS)	T60-T0 (DLS)	T30-T0 (ES)	T60-T0 (ES)
Interquartile Range	0.5	0.5	0.5	0.5
Mean ± Std.	2.74 ± 0.59	2.3 ± 0.48	3.25 ± 0.57	2.78 ± 0.45
paired t-Test	t	df	p	Cohen's d
T30-T0 (DLS) Vs. T60-T0 (DLS)	6.73	39	<.001	1.06
T30-T0 (ES) Vs. T60-T0 (ES)	6.86	39	<.001	1.08
Unpaired t- Test				
T30-T0 (DLS) Vs.T30-T0 (ES)	-3.97	78	<.001	0.89
T60-T0 (DLS) Vs. T60-T0 (ES)	-4.57	78	<.001	1.02
Changes of thickness of attached gingiva (mm)	T30-T0 (DLS)	T60-T0 (DLS)	T30-T0 (ES)	T60-T0 (ES)
Interquartile Range	0.2	0.1	0.1	0.2
Mean ± Std.	0.3 ± 0.11	0.15 ± 0.1	0.41 ± 0.1	0.18 ± 0.09
paired t-Test	t	df	p	Cohen's d
T30-T0 (DLS) Vs. T60-T0 (DLS)	8.61	39	<.001	1.36
T30-T0 (ES) Vs. T60-T0 (ES)	14.48	39	<.001	2.29
Unpaired t- Test				
T30-T0 (DLS) Vs.T30-T0 (ES)	-4.32	78	<.001	0.97
T60-T0 (DLS) Vs. T60-T0 (ES)	-1.17	78	0.244	0.26

Changes in Full mouth Bleeding score (FMBS) measurements.

Table III - illustrate changes in FMBS/Epithelization in both groups during different intervals by Mean ± Std. intragroup comparison manipulated by Repeated Measures ANOVA test while intergroups comparison manipulated by unpaired t- test. FMBS; Full mouth bleeding scores, DLS; Diode Laser Surgery, ES; Electrosurgery, T7; 7days, T14;14 days, T21; 21 days

FMBS	T7 (DLS)	T14 (DLS)	T21 (DLS)	T7 (ES)	T14 (ES)	T21 (ES)
Interquartile Range	4.25	3	2.25	5	4	3.25
Mean ± Std.	16.66 ± 3.88	14.08 ± 3.25	10.68 ± 2.51	17.06 ± 3.56	12.95 ± 2.36	10.2 ± 2.07
Repeated Measures ANOVA	Type III Sum of Squares	df	Mean Square	F	p	η^2
Different intervals of (DLS) group	719.69	2	359.85	125.3	<.001	0.76
Different intervals of (ES) group	952.06	2	476.03	212.82	<.001	0.85
Unpaired t- Test		t	df	p	Cohen's d	
T7 (DLS) Vs. T7 (ES)		-0.48	78	0.632	0.11	
T14 (DLS) Vs.T14 (ES)		1.77	78	0.08	0.4	
T21 (DLS) Vs. T21 (ES)		0.92	78	0.358	0.21	
Epithelization (%)	T7 (DLS)	T14 (DLS)	T21 (DLS)	T7 (ES)	T14 (ES)	T21 (ES)
Interquartile Range	7	2.25	5	6	5	3
Mean ± Std.	59.03 ± 5.02	69.97 ± 3.78	82.45 ± 3.19	61.58 ± 4.1	77.63 ± 4.45	88.98 ± 2.94
Repeated Measures ANOVA	Type III Sum of Squares	df	Mean Square	F	p	η^2
Different intervals of (DLS) group	10990.12	2	5495.06	694.43	<.001	0.95
Different intervals of (ES) group	15162.47	2	7581.23	1148.52	<.001	0.97
Unpaired t- Test		t	df	p	Cohen's d	
T7 (DLS) Vs. T7 (ES)		-2.49	78	0.015	0.56	
T14 (DLS) Vs.T14 (ES)		-8.29	78	<.001	1.85	
T21 (DLS) Vs. T21 (ES)		-9.51	78	<.001	2.13	

Table IV - illustrate changes in different growth factors in both groups during different intervals by Mean ± Std. intragroup comparison manipulated by paired t- test while intergroups comparison manipulated by unpaired t- test. TGF-β1; Transforming Growth Factor-β1, PDGF-BB; Platelet-Derived Growth Factor-BB, BFGF; Basic Fibroblast Growth Factor, DLS; Diode Laser Surgery, ES; Electrosurgery, T0; baseline, T60; 60 days

TGF-β1 (pg/ml)	T0 (DLS)	T60 (DLS)	T0 1 (ES)	T60 (ES)
Mean ± Std.	10.68 ± 1.54	3.42 ± 0.92	10.77 ± 1.38	3.29 ± 0.86
paired t-Test	t	df	p	Cohen's d
(DLS) group T0 Vs. T60	28.45	39	<.001	4.5
(ES) group T0 Vs.T60	31.08	39	<.001	4.91
Unpaired t-Test				
T0(DLS) group Vs.(ES) group	-0.25	78	0.804	0.06
T60(DLS) group Vs.(ES) group	0.63	78	0.53	0.14
PDGF-BB (pg/ml)	T0 (DLS)	T60 (DLS)	T0 1 (ES)	T60 (ES)
Mean ± Std.	3.74 ± 0.71	3.66 ± 0.68	3.73 ± 0.63	3.68 ± 0.65
paired t-Test	t	df	p	Cohen's d
(DLS) group T0 Vs. T60	2	39	0.052	0.32
(ES) group T0 Vs.T60	1.54	39	0.13	0.24
Unpaired t-Test				
T0(DLS) group Vs.(ES) group	0.09	78	0.927	0.02
T60(DLS) group Vs.(ES) group	-0.12	78	0.908	0.03
BFGF (pg/ml)	T0 (DLS)	T60 (DLS)	T0 (ES)	T60 (ES)
Mean ± Std.	1.33 ± 0.18	0.39 ± 0.08	1.29 ± 0.18	0.72 ± 0.12
paired t-Test	t	df	p	Cohen's d
(DLS) group T0 Vs. T60	30.32	39	<.001	4.79
(ES) group T0 Vs.T60	19.68	39	<.001	3.11
Unpaired t-Test				
T0(DLS) group Vs.(ES) group	1.03	78	0.307	0.23
T60(DLS) group Vs.(ES) group	-13.79	78	<.001	3.08

epithelization rate when Diode laser used for crown lengthening and attached gingiva remodeling as following, TNF-β1 r=0.2 p=0.06, BFGF r=0.1 p=0.5, PDGF-BB r=0.02 p=0.88. Also, there wasn't any correlation of growth factors with epithelization rate in electrosurgery technique as TNF-β1 r=0.22 p=0.17, BFGF r=0.03 p=0.81, PDGF-BB r=0.02 p=0.89 (Figure 4).

DISCUSSION

Gingivectomy and gingivoplasty by excision of the sort of tissue wall is considered as a kind of one of clinical crown lengthening type in association with other techniques which involve osseous recontouring. Furtherance in laser and electrocautery techniques have shown a beneficial consequence in the surgical discipline of periodontology, as mentioned in the study of Funde et al. (2015) [12]. They mentioned that Laser and electrocautery have the superiority over the conventional surgical techniques in relation to hemostasis and better wound healing, but also have disadvantages compassing lateral heat damage, uneven wound healing, more handle skills and higher cost. Patients with less than 1 mm width of attached gingival were excluded in the current trial; this in accordance with Lione et al. (2020) [13] they selected only patients with sufficient width of attached gingiva and bone crest >1 mm apical to the CEJ were collected. In the present trial, any cardiac patients or patients with pacemakers were excluded according to Kamal et al. (2016) [14] as they mentioned that electrosurgical unit can create electromagnetic interferences and adversely affect the normal functioning of pacemakers.The same parameters evaluated by Lione et al. (2020) [13] at post-surgery, 1, 3 and 6 months were assessed in this current study. While measuring of width and thickness of the attached gingival were added; Lione R don't measure them. In the current study, all selected patients were medically free and not taking any medications that may cause drug associated gingival enlargement or who were currently pregnant or lactating; this in accordance with Aboelsaad et al. (2013) [15] study that involved 38 patients with no systemic disorders or conditions. The duration of study was only 60 days because complete healing of a gingivectomy wound usually takes between one and two months as mentioned by Abesi and Derikvand review [16] in 2023. Revealed positive effects of selected growth factors on epithelial wound healing after gingivectomy and gingivoplasty operations were observed by Zhang et al. (2021) [17] they mentioned that Fibroblasts and their associated growth factors play a key role through out the process of wound repair. Therefore, the expression levels of FGF-2 and PDGF-BB/PDGFR-β can accurately reflect the progression of wound healing, and these molecules are important targets for research on the effects of drugs on wound healing. Diode laser was chosen in this clinical trial because it is more precise as compared with other systems, including carbon dioxide and Nd:YAG lasers. They are optimal for gingival surgery due to their ability to be absorbed by gingival tissue and not by the adjacent structures in accordance with Hanke et al. (2021) [18]. In

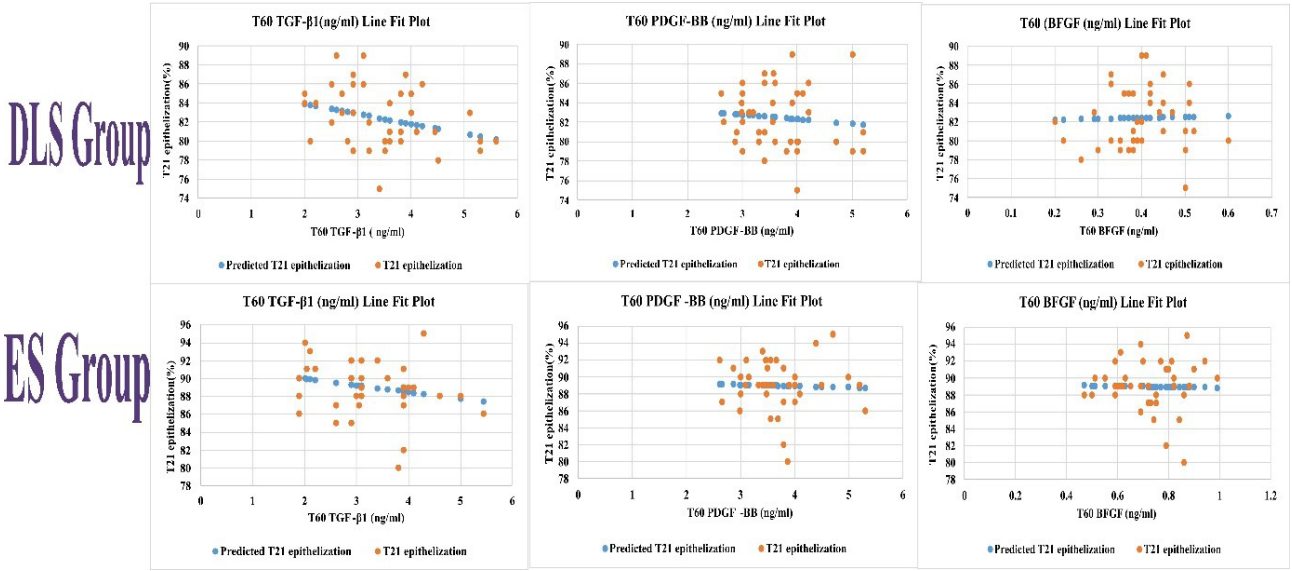

Figure 4 - Correlations of growth factors and epithelization percent. Upper compartment for Diode Laser group (DLS) while lower compartment for Electrosurgery group (ES).

the other side Gill et al. (2021) [19] reported that Nd:YAG and Diode laser have low thermal tissue effects in depth, resulting from a high power loss caused by the of large carbonization zones at the surface of the tissue. In this current investigations, monopolar electrocautery was advocated in according to Hema and Prasanna (2021) [20] study demonstrated that monopolar electrosurgery is used more often than bipolar because the current flows from one electrode to another, makes a broader cut in bipolar than monopolar unit. Monopolar (monoterminal) is an electrosurgical technique in which the tissue effect takes place at a single active electrode and is dispersed (circuit completed) by a patient return electrode. In this clinical trial, clinical parameters were evaluated in harmony with Guler et al. (2019) [21] which recorded that all included individuals subjected to prophylactic periodontal therapy and four weeks later, each volunteer was re-evaluated. All participants had mean full mouth plaque scores <10% and bleeding-on-probing scores < 20% before enrollment. Percentage of epithelization as indictor for tissue healing was evaluated in consonance to Bahar et al. (2024) [22] trial as it showed wound surface epithelialization in the obtaining photographs was estimated by the ImageJ software program. Results of the present study indicated a reduction in bleeding instances with no statistical differences between groups. These results were paralleled with Öncü (2017) [23] which compared the laser with conventional surgery. Also, there was no difference between laser and electrocautery regarding haemostasias as mentioned in Kumar et al. (2015) [24] trial. Changes in dimensions of attached gingiva were parallel with Amorim et al. (2006) [25] study which showed no significant statistical differences were found between the laser and control groups for keratinized attached gingiva. these Changes in dimensions were different than other previous trial of Mavrogiannis et al. (2006) [26] that compared laser and scalpel gingivectomies and found more regrowth of the tissues in the scalpel treated group. González-Martín et al. (2020) [27] study showed that attached gingiva width was significantly narrower in the conventional surgical crown lengthening compared to two-stage crown lengthening. Look closely to epithelization and healing process, results of the present trial were in contrary with small-sized study of Kumar et al. (2015) [24] showed that in the present study, no significant difference in healing was found between laser and electrocautery at 24 h, 72 h, 1, 2, and 4 weeks. Funde et al. (2015) [12] opposed to current investigations as they reported that laser had more advantageous benefits over the electrocautery for remedy of gingival over-growth. Also Mohamed et al. 2020 [28] announced that wound healing process was statistically equivalent in both treatment modalities with better improvement in healing appeared at laser side throughout the healing process. Sawabe et al. (2015) [29] and Taskan et al. (2020) [30] showed that Er: YAG laser provided faster healing period with improved epithelization compared to electrosurgery and diode lasers were reported to increase soft tissue damage caused by large ablation areas and thermal damage. In this trial, the finding of heal process was not completed until 21 days which compatible with study of Stanton et al. (1969) [31] as they clarified that vascularity increases initially, then begins to decrease gradually as healing takes place and returns to normal in about 2-3 week. After 5-14 days surface epithelialization is generally complete, but complete epithelial repair takes about 1 month. In other hand of current research, study for Frenectomy Using Scalpel, Electrocautery & Diode Laser showed that individuals treated with electrocautery had prolonged healing period and takes more time for epithelization [32]. TNF-β levels in this study contradicted the case report of Astuti et al. (2018) [33] with results before gingivectomy and SRP treatment of 1129.736 pg/dl. A week after, gingivectomy decreased to 662.242 pg/dl, and three weeks after, rebounded to 1079.391 pg/dl. TNF-β levels conducted with Sattari et al. (2011) [34] as they found a significant decrease in TGF-β1 level from before surgery to 12 weeks after. Bahar et al. (2024) and Shalaby et al. (2023) [22,35] concluded that Vascular endothelial growth factor (VEGF) levels of the injectable platelet-rich fibrin applied after gingivectomy significantly higher than gingivectomy alone and the Fibroblast Growth Factor 10 (FGF10) of the injectable platelet-rich fibrin applied after gingivectomy were significantly higher than gingivectomy alone without significant difference was found in the intergroups comparisons. Most of the studies concentrated on the effect of laser irradiation as biomodulation after conventional surgery [36,37]. To our knowledge, there is not any study comparing the effects of diode laser and electrosurgery on growth factors after soft tissue crown lengthening and attached gingiva remodeling.

CONCLUSION

Diode Laser and Electrosurgery were considered effective for gingivectomy. Both techniques had the same consequences in gingival epithelization and levels of Transforming Growth Factor-β1 (TGF-β1), Platelet-Derived Growth Factor-BB (PDGF-BB). Electrosurgery was more effective in remodeling of gingival width, So it was better to be used in thin phenotype easthic tissue. Diode Laser had more repercussions in Basic Fibroblast Growth Factor (BFGF) so laser had better thermal control, So it could be used in thick posterior gingival tissue.

Author's Contributions

AMK, SAH: Conceptualization. AMK, AIA, BMB, IHI: Formal Analysis. AMK, BMB, SAH, IHI: Project Administration. AMK, SAH, BMB: Writing – Original Draft Preparation. AMK, BMB, SAH: Writing – Review & Editing. AIA, IHI: Investigation. AIA, SAH, IHI: Methodology.

Conflict of Interest

No conflicts of interest declared concerning the publication of this article.

Funding

The authors declare that no financial support was received.

Regulatory Statement

The Helsinki Declaration ethical guidelines were followed in this trial as its registration was done in The Pan African Clinical Trials Registry (PACTR) databases with ID: PACTR202501765821773. It was approved by the ethics committee of the Faculty of Dentistry, Al-Azhar University, Assiut (approval number AUAREC20220006-5).

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Editor: Maria Aparecida Neves Jardini

Date submitted: 2025 Feb 18
Accept submission: 2025 Aug 27